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ABSTRACT

Learning disabled (LD) adolescents often approach mathematics based on years of frustration and failure. Typical problems in mathematics for the LD student include reversals and transpositions, spatial disorganization on ruled or unruled paper, memorization difficulties, and confusion of concepts relating to reversibility and sequential operational steps. Teaching and learning are enhanced if certain assumptions (such as the importance of recognizing patterns and the need to provide a sequence and structure that help the student recognize and organize patterns) are made. Teaching strategies should avoid repeating the unproductive approaches the student has already been exposed to. Some of the teaching strategies that may help are: providing a reference chart for facts still not learned, using the chart to identify mathematical patterns, and encouraging the child to "draw it out" when he cannot manipulate symbols alone. (DB)

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THE LEARNING DISABLED ADOLESCENT AND MATHEMATICS

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THE LEARNING DISABLED ADOLESCENT AND MATHEMATICS

Introduction

The teacher who undertakes the task of working with the learning disabled adolescent faces both a complex endeavor and individual. Years of frustration have taken their toll upon the student who has expended a large amount of time and energy in order to survive in school. The effects of these years often converge during this critical period of physicological and psychological changes. Therefore, the individual's learning instinct becomes more complicated with feelings of frustration; self-doubt; a sense of inadequacy; resentment towards school, society, family; and a distrust of teachers. Taking these factors into consideration, the teacher must recognize the urgent need to assist the adolescent in coping with himself as well as his school work.

The fundamental understanding of the nature and manifestations of the learning disabled adolescent and his problems with written symbols and spatial orientation is as essential for the mathematics teacher as it is for the language teacher. Without insight into the teaching of language skills for the learning disabled student, the instruction provided by the mathematics teacher may even be ineffective. The student's omission of steps, transposition of numbers, and misalignment of columns appears to be "careless" errors; yet constant explanations, repreated drills, games, and flash cards often fail to accomplish a proficiency in mathematics. These errors cause much frustration for the student and the teacher. The teacher's frustration increases even more when the student seems

to understand a presented concept, but is unable to transfer it to written work or to memory, e.g. the multiplication table.

Characteristics

The learning disabled adolescent's problems in mathematics have their origin in the elementary grades when he first had difficulty performing and learning the basic arithmetical operations. Development of mathematical concepts, vocabulary, and use of symbols were impeded during these early years by problems similar to those which interferred with the student's acquisition of reading and spelling.

By the time this student arrives at the middle or high school, serious deficencies in arithmetical skills prompts a "hating math" attitude. Often the student experiences such difficulties as:

1. reversals, transpositions, inversions and substitutions of numbers when copying from the board, the text, worksheets and/or tests (e.g. 7 as ⌐ , 6 as 9, 39 as 93, 234 as 243, 72 as 75);
2. spatial disorganization as in the poor arrangement of number columns and other work on ruled or unruled paper;
3. confusion in writing numbers from dictation especially when there are many digits or the digit zero is involved (e.g. 9,405,001 as 94051);
4. memorization difficulties, i.e. retaining a series of digits, a series of steps, or the multiplication tables;
5. confusion of concepts relating to reversibility errors and omissions in sequential operational steps;
6. problems in the visual memory of form direction and sequence of numbers and symbols, even after reading skills have been acquired;
7. confusion of symbols that indicate quantitative or other relationships such as "greater than", less than", "equal to", etc. (See Table 1);
8. manipulation of wirtten mathematical symbols involving form perception, memory, sequence and spatial organization in association with concepts (See Table 1);

9. confusion of vocabulary terms such as commutative, associative, distributive, numerator, denominator, prime number, prime factor, carrying, and borrowing.

Assumptions about Learning and Teaching

In working with the learning disabled adolescent, there are certain assumptions about learning that can be made.

Assumption 1: Learning involves the recognition of patterns which become bits of knowledge that are then organized into larger and more meaningful units.

Assumption 2: Learning for some children is more difficult than for others because of visual, auditory, or motor deficits that interfere with the ready recognition of patterns.

Assumption 3: Some children have difficulty with the organization of parts into a whole due to a developmental lag or a disability; i.e. with integration, sequencing, memory, or spatial relationships.

Then, there are certain assumptions about teaching that can be made.

Assumption 1: Communication in teaching should insure that the learning task is made clear to the learner and that the student's problems in learning are clear to the teacher; i.e. teaching should provide experiences that serve to clarify the learning task so that the student will know what is to be learned.

Assumption 2: The student must be provided with a sequence and structure that will enable him to recognize the patterns into which he must organize larger and more meaningful units. The experiences that develop this sequence and structure must be designed

a. to circumvent or overcome sensory modality defects or weaknesses,

b. to circumvent the problems of spatial or temporal relationships or sequencing,

c. to develop organization and integration,

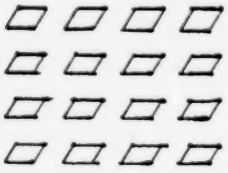
d. to provide the association that will insure memory.

Assumption 3: It must be recognized that the learner needs to internalize each concept learned as the basis for further learning. Bruner (1965) has noted that learning should not only take you somewhere, but it should allow you to move ahead more easily.

Suggestions for Teaching Mathematics

A first step in working with a learning disabled adolescent is to avoid repetition of the type of teaching which has proven unproductive in the past. For example, if the multiplication facts are still not mastered (not uncommon in the learning disabled student), additional drill will probably prove futile. Instead, a reference chart can be constructed for use while concepts are being learned.

Working with this reference chart alone may be insufficient and may require additional strategies, one of which is manipulating square tiles. With this concrete experience, the student can discover, for example, that 4 x 4 = 16 and that $4^2 = 16$.



1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

Similarly the student can locate 3^2, 7^2, 9^2, etc. until he discovers a pattern. At this point, the process can be reversed to

find the square root of 9, 36, 81, 49, etc. The meaning of the words root and radical can be explained in relation to the root the student knows as a vegetable--radish, thus using the Latin derivatives of the words radical and radish to build a further association.

Therefore, as the student is working with the power of two and square roots, he discovers the inverse relationships not only of square and square roots but also of multiplication and division with the underlying law of inverse operations. Also, the teacher is providing the student the opportunity to discover order in arithmetic. Even Piaget (1971) has noted that the reason it takes a child so long to recognize simple, logical rules is that these rules are not "out there" but must be constructed from the activity of the child himself. The adolescent may not have been able to construct these rules from earlier instruction and may need concrete experiences as the basis for his development of logical thinking in mathematics.

Accordingly, it should be noted that the student progresses through the following levels: (Bruner, 1966)

enactive level:	involves direct manipulation of concrete objects
ikonic level:	involves mental images of objects
symbolic level:	involves the manipulation of symbols without mental images (abstraction)

With careful structure, organization, and sequencing of a mathematics program by the teacher, the adolescent (though still needing many concrete experiences) can often make this progression rather quickly.

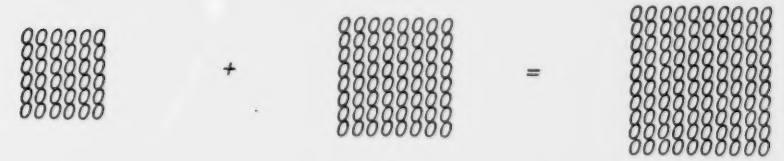
To demonstrate the law of inverse relationships, the teacher might initially choose to work with exponents rather than with

addends, so that more can be accomplished than mere order. This approach has its benefits. First, it avoids placing the adolescent in a humiliating position of "first grade" arithmetic. Second, it indicates that the teacher recognizes that the adolescent develops differently from the young child in congitive operations. This is important to help the student overcome old feelings of inadequacy and still challenge the student intellectually even while working at an elementary level. Finally, it is important to provide the student with a basis for understanding other properties of mathematics as shown on the following pages. For example, the student is able to move from $8^2 + 6^2$ to $(8^2 + 6^2)$ to 10^2. In this process, he sees that 10^2 equals 100 and begins to recognize the communative principle ($8^2 = 64$; $6^2 = 36$; $64 + 36 = 100$; $36 + 64 = 100$). Since he had also been discovering how to find the square root, he knows that 100 is 10. Thus, the student can deal with the following expression:

$$8^2 + 6^2 = \underline{\quad ? \quad}.$$

64 + 36 = 100

OR



36 + 64 = 100

$\therefore \sqrt{8^2 + 6^2} = \sqrt{64 + 36} = \sqrt{100} = 10$

SO $x = 10$

Verbalization accompanies the previous visual-motor and concrete operation as it is transferred into its symbolic expression. These notations are done in the student's notebook so he will be working on ruled paper and will be able to review or refer to it when necessary. It is important that the student writes out each step in the thought process from the beginning, using appropriate notations as previously illustrated so that he will become accustomed to work in a sequence of operations. (N.B. Manual manipulation continues as long as necessary.)

As soon as the student is able to do so, he moves from the physical manipulation of material to non-symbolic stage of visualization through the use of drawings that represent numbers, sets, or relationships. Then, he finally works with only symbols so that "when in doubt, draw it out" is an accepted method when he cannot manipulate symbols alone. (When working with symbols alone, make sure that all steps are included as shown below.)

Example 1: Solve for "x"

$$\left(\frac{12^2 \times 4^2}{16}\right) \times \left(\frac{5^2 \times 8^2}{25}\right) = x$$

$$\left(\frac{144 \times 16}{16}\right) \times \left(\frac{25 \times 64}{25}\right) = x$$

$$\left(\frac{2304}{16}\right) \times \left(\frac{1600}{25}\right) = x$$

$$144 \times 64 = x$$

$$9216 = x$$

Example 2: Solve for "χ" and find the square root of "χ".

a) $\chi = (\sqrt{144}) + (2)(23)$

$\chi = 12 + 69$

$\chi = 81$

b) $\sqrt{\chi} = \sqrt{81} = 9$

$\therefore$ *The square root of* χ *is 9*

N.B. This is only one approach in developing the skills of the learning disabled adolescent in mathematics. Various other methods are encouraged to meet the learning needs of this type of student.

TABLE #1

Mathematical symbols that may present possibilities for visual and conceptual confusion

$>$	greater than	$<$	less than
$\cup$	union	$\cap$	intersection
6_8	subscript	6^8	exponent
$=$	equal to	$\neq$	not equal to
$\geq$	greater than or equal to	$\leq$	less than or equal to
$\sim$	is similar	π	pi
$\Rightarrow$	implies	$\Leftrightarrow$	if and only if
$\perp$	is perpendicular to	$\angle$	angle
$\in$	is a member of	$\notin$	is not a member of
$\pm$	plus or minus	$\cong$	approximately equal to

possible rotations:

52 · 25 | 25 · 52

96 | 66

$3\frac{1}{4}$ $\frac{1}{34}$ $\frac{31}{4}$ | $3\frac{4}{1}$ $\frac{34}{1}$ $\frac{4}{31}$

36 · 63 | 39 · 93

12 | 21

$\frac{1}{4}$ $\frac{4}{1}$ | $\frac{1}{5}$ $\frac{5}{1}$

$\frac{1}{6}$ $\frac{1}{9}$ | $\frac{6}{1}$ $\frac{9}{1}$

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